

## NICKEL ALUMINIDE TRANSFER ROLLS FOR STEEL MILL FURNACES

### Benefits

- Reduced furnace downtime for transfer roll repair
- Reduced damage to the steel being processed, thus improving steel quality and consistency
- Reduced amount of steel that is rejected and must be reworked/remelted
- Increased mill throughput
- Reduced energy consumption, leading to annual industry-wide savings of over 10 trillion British thermal units (Btu)
- ASTM-approved specification (A 1002-099)
- Applications in heat treating, forging, and other high-temperature industries

"We are very enthusiastic about the nickel aluminide rolls – they have shown a lot of promise."

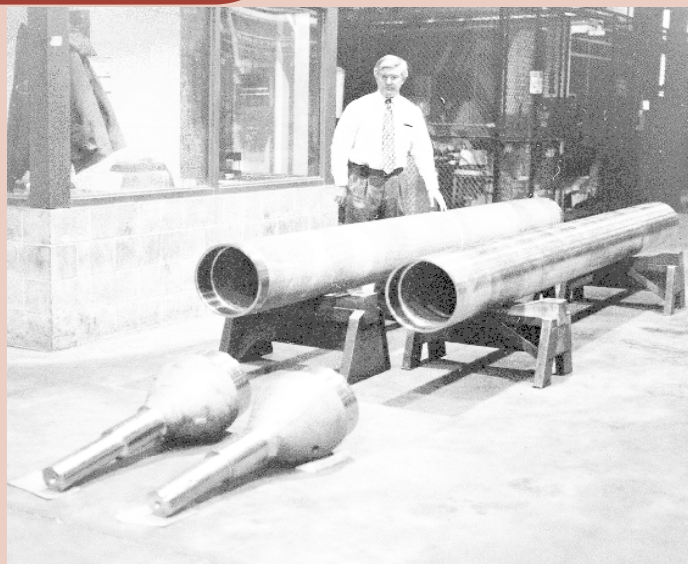
---- Tony Martocci, Program  
Manager for Corporate Energy  
Affairs, Bethlehem Steel Corporation

### INTERMETALLIC ROLLS OFFER SUPERIOR PERFORMANCE IN HIGH-TEMPERATURE ENVIRONMENTS

Rolling devices are used throughout the steel mill to transport hot steel from the continuous caster through other processing areas such as finishing mill equalizing roller hearth tunnel furnaces and post rolling heat treating roller hearth furnaces. These rolls come into direct contact with the hot steel being processed. The high temperatures in the reheating and other furnaces in which the rolls operate cause them significant thermomechanical stress, which can hasten the need for expensive repair/replacement in addition to physically marring the raw steel being processed. When the rolls crack or blister as a result of thermal fatigue, the furnace must be shut down and the rolls ground smooth or even replaced. The blistered roll leave marks on the steel product, thereby necessitating the refinishing -- and in extreme cases, complete remelting -- of the steel to comply with specifications.

Reworking and remelting "out-of-spec" steel has significant cost and energy penalties. The impact of blistered transfer rolls on productivity and yield is even more severe: when the condition of a roll deteriorates enough to warrant repair or replacement, the furnace must be completely shut down. Superior metal alloys are needed to manufacture rolls more resistant to the thermal and physical damage that can occur in the harsh conditions found in high-temperature steel mill furnaces. Furnace rolls made from new intermetallic alloys are less susceptible to this kind of damage, reducing mill downtime and boosting productivity.

### Ni<sub>3</sub>Al ROLLS IN BETHLEHEM STEEL



Blister-free Ni<sub>3</sub>Al furnace rolls in austenitizing furnaces are operating and evaluated at Bethlehem Steel.



## Solution

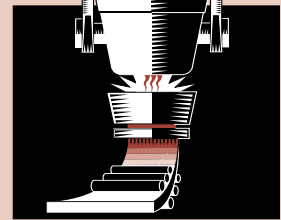
In collaboration with Oak Ridge National Laboratory and Sandusky International, Incorporated, DOE's Office of Industrial Technologies has developed nickel aluminide alloys for use in steel mill transfer rolls through its Advanced Industrial Materials Program (AIM). Industry partners Bethlehem Steel, U.S. Steel, and North Star Steel have provided input regarding product refinement and new alloy development. Nickel aluminide alloys, when compared to the traditional transfer roll compositions, demonstrate superior oxidation resistance, strength, creep, and fatigue resistance.

The new nickel aluminide transfer rolls are less susceptible to the defects commonly exhibited by other roll materials upon prolonged exposure to the harsh environment of a steel reheat furnace. A new nickel aluminide alloy, IC-438, is still in its early stages of development but already has shown significant promise due to its exceptional behavior at higher temperatures. The IC-221M variety of nickel aluminide is the principal alloy currently in use.

## Results

Currently, 22 rolls made of the nickel aluminide alloy IC-221M are in commercial operation in the 160-inch plate mill annealing furnace at Bethlehem Steel's Burns Harbor Plant in Indiana. Bethlehem Steel is currently considering an upgrade to this furnace that would include the installation of additional nickel aluminide rolls. In addition, three 17-inch (outside diameter) rolls of nickel aluminide alloy IC-221M have been fabricated for installation at an austenitization furnace at a U.S. Steel facility in Monroeville, Pennsylvania. Prototype manufacturing and in-plant testing are continuing for an additional nickel aluminide alloy – IC-438 — capable of operating at even higher temperatures.

The nickel aluminide IC-221M represents the first intermetallic to receive ASTM approval, allowing commercial users to order the rolls to a certified ASTM specification (A 1002-099). To date, the rolls have presented fewer cracking and blistering problems than traditional transfer rolls, providing immediate and significant energy savings. The use of nickel aluminide furnace transfer rolls alone is expected to save about 20 trillion Btu annually by the year 2020, with additional savings realized from other applications of these superior intermetallic alloys.



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